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as clearly and as well set forth as in any book on Africa. Each chapter is preceded by a summary giving the essentials of the several topics discussed. The work is marred by comparatively few errors.

**Die Eisenbahnen des Brasilianischen Staates São Paulo. Von Alberto Kuhlmann.** 39 pp. Illustrations and Map. Published by the Author, São Paulo, 1904.

The late Mr. Kuhlmann had special facilities and equipment for giving the history of the development of the railroad system in São Paulo. The pamphlet contains a relief map of the zone between Santos and São Paulo, a considerable number of excellent photographs that help the text, gives a clear insight into the condition of railroad transportation in that region and outlines the future of the industry, as the author believed it would develop in São Paulo. We quote from the work:

No country in the world, excepting the United States, has shown such progress economically, and especially in the sphere of railroads as the State of São Paulo in Brazil. The fact that all these lines, with the exception of two or three, are working profitably, is of the greatest consequence in the development of the railway system, showing, as it does, that it was not purely a speculative enterprise. The immense capital, foreign and domestic, which is sunk in these lines, as well as the almost incalculable material necessary for the construction and working of them, are facts of general interest.

**Geology. By Thomas C. Chamberlin and Rollin D. Salisbury.** Vols. II and III. New York, Henry Holt and Company, 1906.

The scientific public is to be congratulated upon the completion of this masterly treatise upon Geology, which gives in succinct form the principal features of the most advanced thought and the latest investigations in one of the most rapidly developing sciences of the present day. The first volume of this monumental work dealing with geological processes and their results appeared two years ago, and was briefly reviewed in the BULLETIN for May, 1904. The second and third volumes treat of the "History of the Earth," the division between the two volumes being at the end of the Permian period, an epoch of the highest importance in the geological history of the earth. When the first volume was issued the authors announced that the work was to be completed in two volumes; the growth of the part devoted to earth history from one volume to two is an indication of the vast amount of material which has been utilized in the treatise.

In the preface the authors state that their effort throughout has been "to keep the discussion as free from technicalities as practicable and to render the matter readable." Technicalities can hardly be avoided in the elaboration of such abstruse and fundamental ideas as are treated in these volumes, but "readable" the whole book certainly is. Clear English, direct statement, distinct separation of theory from fact, abundant illustrations, and many illuminating diagrams and maps combine to make the rather ponderous tomes a constant delight and inspiration to the professional geologist and a necessary handbook to the advanced student. The new geology does not pretend, however, to be a manual; it is rather a discussion of basal principles and of geological formations in their broad characteristics and relations. Details of the geology of particular regions are omitted, except where needed for the comprehension of generalized statements.

The first pages of Volume II plunge the reader at once into the intricacies of expositions of the main theories that have been advanced to account for the origin of the earth and the solar system. After a brief but compendious statement of the still generally accepted so-called "Nebular Hypothesis" of Laplace, together

with proposed modifications bringing it more into accord with modern thought and investigation, and a more extended discussion of the Meteoritic Hypothesis as modified and elaborated by Lockyer and G. H. Darwin, our authors pass on to a succinct elucidation of the Planetesimal Hypothesis, which has gradually been elaborated by Chamberlin during the past ten years or more. Regarding this new theory we can do no better than to quote the summary thereof given by its sponsor (Vol. II, p. 81) :

The planetesimal hypothesis thus assumes that the solar system was derived from a nebula of the most common type, the spiral, and that the matter of this parent nebula was in a finely divided solid or liquid state before aggregation, in harmony with the continuous spectra of spiral nebulae. It regards the knots of the nebula as the nuclei of the future planets, and the nebulous haze as matter to be added to these nuclei to form the planets. It assumes that both the knots and the particles of the nebulous haze moved about the central mass in elliptical orbits of considerable, but not excessive, eccentricity. It postulates a simple mode of origin of the nebula connected with the not improbable event of a close approach of the ancestral sun to another large body, but the main hypothesis is not dependent on this postulate.

It assigns the gathering-in of the planetesimals to the crossing of the elliptical orbits in the course of their inevitable shifting. Out of this process and its antecedents, it develops consistent views of the requisite distribution of mass and momentum, of the spacing out of the planets, of their directions of rotation, of their variations of mass, of their varying densities, and of their peculiarities.

It deduces a relatively slow growth of the earth, with a rising internal temperature developed in the central parts and creeping outward. With such a mode of growth, the stages of the earth's early history necessarily depart widely from those postulated by the Laplacian and meteoritic hypotheses.

Having promulgated the new theory at length, Chamberlin and Salisbury do not seek to explain the history of the earth by it to the exclusion of the consideration of the older theories. On the contrary, in each instance the modified Laplacian hypothesis is cited fairly and the objections to it stated clearly before the accretion (planetesimal) hypothesis is brought forward. The weak places in the new theory, too, where recognized, are stated. Whether the reader accepts the accretion theory or not, he must appreciate the masterly manner in which the authors have stated the difficulties which have been encountered in the application of the gaseo-molten (modified Laplacian) hypothesis. The divergence of the new theory from the old is shown most strikingly in the discussion of the hypothetical stages leading up to the known geological eras and of the partly known Archæan era. The importance of the bearing of the accretion theory is shown further in the discussion of vulcanism (mostly in Volume I), deformation, atmosphere, and climate (including glaciation).

The work lays more stress upon the physical than the palæontological side of the science, *i. e.*, it is a treatise upon geology, not palæontology, and a noteworthy feature is the absence of the long lists of the fossils characterizing the formations which are to be found in nearly all general geologies. Much attention, however, is paid to the question of the rise, distribution, and disappearance of one fauna and flora after another and to the consideration of the causes leading to these changes in the life upon the earth. North America is taken as representative of the whole earth, and comparatively little is said about the geology of the other continents. These two volumes, therefore, give "a connected and interpretative sketch" of the earth, as illustrated particularly by this continent. Throughout the work stress is laid, as far as knowledge warrants, upon the surface features of the progressive stages of the land and upon the permanence of the continents. In this connection mention should be made of the series of maps showing the continent of North America in the successive periods, because they represent not only the present surface distribution of the rocks of the period, but

also the probable concealed extension of the beds beneath later formations, the degree of probability being indicated by shading. A sufficient number of excellent figures illustrates the characteristic fossils (*Leitfossilien*) of the formations, without going far into the details of species. An important feature of the work is the general geological map of the United States and part of Canada compiled by Mr. Bailey Willis with the aid of geologists of the U. S. Geological Survey. Such a compilation had not been made before in twenty years, during which period enormous strides had of course been made in the knowledge of the geology of many parts of the country. The map bears the date of 1903.

In the arrangement of the subdivisions of the geological scale some changes have been introduced which will at once attract the attention of the reader who is familiar with the older textbooks and manuals. The term Proterozoic, originally proposed by R. D. Irving, is revived and given equal rank with Paleozoic in the time scale. It has the same meaning as the Algonkian of the U. S. Geological Survey, and comprises the Huronian, Animikean, and Keweenawan, covering the interval between the Archeozoic (Archean) and the Paleozoic. Williams's names Mississippian and Pennsylvanian are adopted for the Subcarboniferous and Coal Measures respectively, while Hill's name Comanche is used for the Lower Cretaceous of authors, and the term Cretaceous is restricted to the Later, or Upper, Cretaceous of previous treatises. Contrary to the law of priority and the usage of Dana, Geikie, and other authorities (except de Lapparent), Lapworth's name Ordovician is used for the Lower Silurian of Murchison. This use of the term Ordovician is spreading in the United States, but it works great injustice to the labours of Sir R. Murchison, and is to be deprecated.

A noteworthy and valuable feature of the stratigraphical portion of the work is the publication in tabulated form of the geological sections in several typical areas of the country. The sections which are given in connection with several of the great periods are supplemented in the Appendix by twenty-two sections for the entire geological scale as represented in as many parts of the United States from Massachusetts to Florida. These are conveniently presented for ready reference.

As was to have been expected from the character of most of the field work of both authors, much stress has been laid upon the subject of glaciation in all its bearings. Boulder-bearing beds containing striated stones have been found in Norway and in China, which indicate the occurrence of extensive glaciation during the opening stages of the Paleozoic previous to the undoubted Cambrian. The chief ancient glacial period, however, was at the close of the Permian in England, South Africa, India, and Australia, and new illustrations from South Africa are published. The fact is brought out that this Permian or Permo-Carboniferous glacial period affected a much larger area than was covered by ice during the Pleistocene glacial period, and its distribution was equatorial rather than circum-polar, like the Pleistocene glaciation. This localization of the glaciers is considered to be the most puzzling feature of the whole problem, and the explanation of it is thought probably to lie in the great late Paleozoic development of the land connection from South America *via* Antarctica to New Zealand and thence to Australia and India, which concentrated warm waters in the Pacific and cold waters in the Indian Ocean and produced profound climatic changes. At the same time a broad tongue of the Arctic sea is supposed to have occupied eastern Russia and western Turkestan, co-operating with the peculiar conditions in the southern hemisphere to produce refrigeration in low latitudes.

Limitations of space forbid our reviewing in detail all the features of this great work, and we pass over almost in silence the discussion of Mesozoic and Cenozoic time, with its abundant reference to the labours of the vertebrate palaeontologists, which have added so extensively to our conceptions of physiographic and climatic conditions in western America as well as to our knowledge of the animal forms peopling the continental land surfaces. The probability, too, is admitted that many beds formerly assigned to great Tertiary lakes are of æolian or sub-aërial origin and that lakes were incidents rather than characteristics of Tertiary time.

Turning to the Pleistocene, or Glacial, period, many of the younger readers of this book will be surprised at the marshalling of facts to prove the glacial origin of the great deposits of clay, sand, and boulders which we know as "Drift" and which cover half the plains of North America and vast areas in Eurasia, so generally accepted at the present day is the fact of extensive glaciation in the northern hemisphere in recent geological time. Six invasions of the great ice sheet are recognized; but they were of unequal extent and duration, and were separated by unequal intervals of time, and consequent recession. The stages are, beginning with the earliest: (1) Sub-Aftonian, or Jerseyan, (2) Kansan, (3) Illinoisan, (4) Iowan, (5) Early Wisconsin, (6) Late Wisconsin.

The æolian origin of the Loess is held to be most probable, the material being considered to have come from river bars and flats exposed in times of low water and from the rock-flour brought down by the continental ice sheets. The evidence for the appearance of man in North America before the final retreat of the continental ice sheets is thought to be sufficient.

The theories which have been advanced to account for the Glacial period are (1) the hypsometric hypotheses, or those appearing to elevation of the land, (2) the astronomic hypotheses, such as variations in the eccentricity of the earth's orbit and the wandering of the earth's axis of rotation, (3) the atmospheric hypotheses, or those which appeal to changes in the constitution or movements of the air. Reasons are given for discarding the first two groups of hypotheses, and then the arguments in favour of the third are brought forward, at some length.

Our authors consider that the general conditions favourable to glaciation were supplied by the extensive deformation of the land which took place at the close of the Pliocene period, resulting in great changes in the circulation of oceanic currents, in the acceleration of the vertical circulation of the atmosphere, and in the reduction of the average temperature of the atmosphere by a depletion of moisture and carbon dioxide. The localization of the glaciation is assigned to the two great areas of permanent atmospheric depression that have their present centres near Greenland and the Aleutian Islands respectively, and which may be presumed to have been extended and intensified during the glacial stages. The explanation of the periodicity of glaciation is based upon the conception that under conditions favorable for glaciation certain of the agencies involved became dominant and tended to intensify and accelerate glaciation for a time, until they either pushed the effects to an extreme from which a reaction was inevitable, or they exhausted themselves temporarily, while other agencies of opposite phase, which had been subordinate until then, became dominant and forced a reaction.

Each volume is supplied with a copious index besides a full table of contents, the index to Volume III being general for the whole work.

E. O. H.